A Mesoporous Structure SnP$_2$O$_7$/Graphite Oxide Composite as Proton Conducting Electrolyte for High-Temperature Proton Exchange Membrane Fuel Cells

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doi: 10.20964/2017.05.78

Received: 25 January 2017 / Accepted: 16 March 2017 / Published: 12 April 2017

Proton conductors operated in over 200°C have received great interest for proton exchange membrane fuel cells (PEMFCs). The tetravalent metal ion pyrophosphates materials (MP$_2$O$_7$) are considered as the suitable conductor electrolyte, and the mesopores structure MP$_2$O$_7$ are attractive, because capillary condensation of water molecules occurs at relatively low relative humidity, allowing for fast transport of protons without excessive humidification. In this study, we report meso-SnP$_2$O$_7$, which is synthesized from mesoporous SnO$_2$, as promising solid electrolyte candidate for PEMFCs in a temperature range of 180°C to 280°C. Furthermore, graphite oxide (GO) is incorporated with the meso-SnP$_2$O$_7$ to further improve the proton conductivity and water retention. The structure and phase stability of the membranes are analysed by X-ray diffraction (XRD) and thermo-gravimetric analysis (TGA). The microstructure morphology of SnP$_2$O$_7$ particles and pellets is analysed by transmission electron microscope (TEM) and scanning electron microscopy (SEM). The obtained particles and pores size of Meso-SnP$_2$O$_7$ are characterized by the ETA potential meter and BET. The Meso-SnP$_2$O$_7$ and Meso-SnP$_2$O$_7$/GO electrolytes exhibit the high proton conductivities of 0.15 S cm$^{-1}$ and 0.17 S cm$^{-1}$ at 220°C, respectively. Moreover, the peak power density of the Meso-SnP$_2$O$_7$/GO membrane is 18 mW cm$^{-2}$ at 220°C with OCV of 0.83 V.

Keywords: High-temperature proton exchange membrane fuel cells; Graphite Oxide; mesoporous structure; capillary condensation

FULL TEXT